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Reply

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I would like to thank Dr Miyamoto for an insightful analysis of our article. It is well known that biologic systems are extremely complex, with multiple interconnected and redundant pathways. A full understanding of such a system requires an integrated approach to data analysis.¹ Although our appreciation of the cellular/molecular impact of resuscitation has improved tremendously in recent years,² we still have not fully deciphered all the pathways. Dr Miyamoto, in his letter, has suggested possible mechanisms when an increase in total Akt level (without an increase in the phosphorylated Akt) might have caused the downstream effects in selected resuscitation groups. I agree that this is one of many possible explanations. For obvious logistical reasons, it was not possible for us to explore every possible pathway and investigate every potential option. He is completely correct in pointing out that the eventual fate of cells depends on the balance between pro- and anti-apoptotic forces. This dynamic process is influenced by countless variables and a single study, no matter how sophisticated, is unlikely to provide all the answers. I do hope that our data would serve as a catalyst for Dr Miyamoto to investigate some of the possibilities mentioned in his letter. There is now an increasing body of literature describing the beneficial properties of ketone bodies and pyruvate (some cited in his letter), and I completely agree with him that it "... might be better to adopt either PR [pyruvate Ringer's] or KR [ketone Ringer's] instead of LR [lactated Ringer's]." Although

ketone and pyruvate Ringer's solutions are currently not approved for clinical use, we do have the option to use Ringer's lactate that does not contain the harmful D-isomer. Once again, I would like to thank Dr Miyamoto for his interest in our work and for his very thoughtful comments.

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Emergency Tourniquets

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There is currently a good deal of interest relating to tourniquet use for hemorrhage control after trauma. So we were pleased to see the recent article entitled, "A Balanced Approach to Tourniquet Use: Lessons Learned and Relearned," by Welling and coauthors¹ in the July 2006 issue. The stated intent of the article was to review historical data and comment about modern tourniquet use. But the authors did not include several critical, informative, peer-reviewed articles. In addition, several important articles were published between the time of acceptance and actual publication.

The literature review was incomplete and omitted a number of articles that deal with the issues the authors sought to review. These include articles dealing with military tourniquet use,^{2,3} testing,^{4,5} use recommendations,^{2,3,6} and data on tourniquet use in the field.^{2,3} In the portion dealing with World War II, they did not include the seminal article by Wolff and Adkins,³ which documented more than 200 cases of tourniquet use in a single winter during World War II.

We take issue with a number of the statements made in the paragraph that discusses the "new field tourniquet" (page 113, paragraph 1). The statement, "... it is

less clear that it is more effective than other tourniquets,” referring to the Combat Applications Tourniquet (CAT), is problematic on two levels. First, this tourniquet was selected from nine other candidates as a result of careful laboratory testing on human volunteers⁵ and field testing by army medics. All of the tourniquets tested were available commercially, and many failed to stop Doppler pulse. So, in fact, the CAT was more effective than other tourniquets. Implicit in this same statement is the authors’ apparent belief that any tourniquet can work. This is definitely not the case.²⁻⁷

On page 114, the authors presented current recommendations for use of tourniquets. These guidelines are based on Advanced Trauma Life Support (ATLS), which is not relevant for prehospital care. The appropriate guidelines for military tourniquet use are outlined in the *Pre Hospital Trauma Life Support (PHTLS) Manual: Military Edition*.⁸ This manual gives instruction on what care should be rendered by the medic depending on which phase of the battle he or she is in (“Care under fire,” “Tactical field care,” or “Casualty evacuation”). In the “Care under fire” phase, use of a tourniquet is the first line of choice for treatment of extremity hemorrhage. The medic is advised to take the tourniquet off only if the solution latter allows. These recommendations were formulated by a panel of military and civilian trauma physicians, nurses, and medics.

We hope this additional information is helpful. In closing, we would like to add that it is our anecdotal experience from the current conflict that countless lives have been saved because of the combined results of the presently issued effective tourniquets and new tourniquet use doctrine and training. We all share the common concern that our soldiers, sailors, airmen, and marines receive the best possible care based on the most current scientific and medical information.

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Reply

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We appreciate the careful analysis and thoughtful suggestions of Drs Walters, Holcomb, Cancio, Beekley, and Baer, our talented colleagues at the Institute of Surgical Research. They rightly point out that there were other articles worthy of mention that were not included in our review about tourniquets. They have authored or coauthored several of these articles. We tried to include representative references from a very large body of work that began in the Middle Ages. The development, by Walters and colleagues, of a model tourniquet currently deployed with our troops has been a very important effort and continues to save lives on the battlefield.

Our purpose was to emphasize the need for adequate training in the use of tourniquets by those who might use them. The historical perspective on the reasons for waxing and waning of enthusiasm for the use of tourniquets, over hundreds of years and many wars, is important to this discussion. There have been many amazing tourniquet devices. The popularity swings of tourniquet use have had much more to do with the understanding of and training in use of tourniquets than with the available devices themselves.

As with all medical therapeutics, there are risks and benefits that must be balanced. The tourniquet must be properly applied. Education in hemorrhage control and the role tourniquets can play is more important than the particular tourniquet device. The rescuer must know